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Zoom meeting D ：11/2 AM1 (9:00-10:30)
9:00～9:15

On plasmasphere formation around terrestrial exoplanets: Possible evidence of exoplanetary intrinsic magnetic field and atmosphere

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There have been discovered many exoplanets and the number of terrestrial exoplanet detection increases rapidly in recent ten years. Many terrestrial exoplanets or super-Earth are found around low mass stars such as M dwarfs. A red dwarf (M type star) has comparatively narrow habitable zone, which is very close to the host star, and exoplanets are considered to be exposed to extreme levels of X-ray and ultraviolet (UV) radiation. Classic equilibrium tide theories predicts that K or M-type stars induce strong tidal effects on potentially habitable exoplanets, and tidal locking is possible for most planets in the habitable zones of K and M dwarf stars [e.g., Barnes, 2017].

When a planet has dipole magnetic field and rapid rotation, superposition of the stellar wind induced and corotation electric fields results in the tear-drop-shaped region of the closed drift, where planetary ionized atmosphere can fill the magnetic flux tubes along the field lines. The region is characterized with cold dense planetary plasma and called as the plasmasphere. In this study, a simple estimation method of the size of terrestrial exoplanetary plasmasphere is shown based on the knowledge of the solar system planets. We considered the role of rapid rotation of the atmosphere (superrotation) in the formation of the plasmasphere of tidally-locked exoplanets. Many GCMs of exoplanets show that the circulations of typical tidally locked terrestrial exoplanets can become superrotation [e.g., Showman+, 2013]. However, the horizontal circulation in the thermosphere is far from understood [e.g., Machado+, 2017].

The results indicate that Earth-like magnetized exoplanet can have a plasmasphere with a size of 4-6 times of the planetary radius. The size of the plasmasphere depends on the superrotation speed of the thermosphere, ionospheric conductance, stellar wind dynamic pressure, and IMF cone angle. If the exoplanet has a CO_2-rich atmosphere, the results suggest the FUV absorption of plasmaspheric C+ ions might be observable by space telescopes. Since the plasmasphere formation requires the existence of both the thick atmosphere and global intrinsic magnetic field, the observation of plasmasphere can provide possible evidence and clues of the exoplanetary atmosphere and intrinsic magnetic field.

References:

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